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Invention:

APPARATUS FOR PROVIDING RESISTANCE TO CARGO SPILLS AND TERRORISM AT SEA

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APPARATUS FOR PROVIDING RESISTANCE TO CARGO SPILLS AND TERRORISM AT SEA

Background of the Invention

The History of Petrochemical Transportation

Because of the wide diversity of locations where oil is harvested from earths' underground reservoirs, it is necessary to transport the crude oil from a land or sea-based location to many sites across the globe for refinement. History books have recorded massive spillage of crude and catastrophic ecological damage during this transportation phase because of hull failure of the vessel transporting the crude. While oil spill ***prevention*** is the primary purpose of this invention, the invention contemplates the prevention of spills of various types of liquids and gasses, primarily in the petrochemical industry.

Related Application

This application is a Continuation-In-Part Application of United States Patent Application Serial No. 09/676,900, filed on October 2, 2000 and also claims priority from United States Provisional Patent Application Serial No. 60/165,421, filed on November 13, 1999, entitled Method and Apparatus for Preventing Cargo Spills, filed by and on behalf of Keith A. Robinson.

Currently Used Technology

Currently, only one transport process is being considered to significantly lower the risk of ecological damage resulting from the breach in the hull integrity of petrochemical transport vehicles: *The Double Hull.* Oil tankers built now and in the future are required by the Oil Pollution Act of 1990 (OPA '90) to use double hulled construction to reduce the risk of oil spills

due to grounding and collision, and the resulting adverse impact on the environment. Although the use of double hulls is a step in the right direction, it does not fully eliminate the likelihood of oil spills since the inner hull can still be penetrated in major accidents. Major oil spills, such as the 1989 Exxon Valdez oil tanker spill at Bligh Reef in Prince William Sound, Alaska, can have devastating impacts on the environment, and the cost of oil recovery and restoration of the environment can be extremely high. Although the double hull is currently perceived by the public and political figures as the most "politically correct" solution to the problem, after lengthy review of the options available, the double-hull concept is flawed and still capable of failure for the same reasons as the single hull. Even with the destruction ot the entire remaining existing fleet of tankers, barges, and intermediate vessels and the expenditure of billions of dollars for the construction of The Double-Hull vessels, it is a fact that the Double-Hull vessel is ***still*** capable of being pierced or crushed by an incoming object when the force of that object exceeds the strength of the hulls. The Double-hull proponents merely hope that two hulls are enough. Recent history reaffirms that even two hulls are not enough. Even with this knowledge, the petrochemical industry, driven by legislative momentum, a massively powerful and financially well-endowed lobbying organization and the ongoing voluntary implementation of the Double-Hull vessels into the current transportation, there appears to be a feeling among the major petrochemical interests that the cost of correcting the flaw in the vessel construction problem would not find a receptive market. Once again, the industry appears to accept petrochemical cargo spillage as 'another risk of doing business."

Previous patents have struggled admittedly to only minimize the risk of hull breach with the use of various forms of bladders and reinforcement. Yet, each such patent admits that the loss of cargo would occur should both the bladder and its reinforcement be pierced during a hull breach.

This present invention allows the existing fleet of small, medium and large, single-hull and double-hull vessels that function as petrochemical transport vessels on various scales of magnitude, and VLCC (Very Large Crude Carriers) having single hulls to be converted and retrofitted to become more ecologically safe and physically predictable to unexpected hull pressures. Because of the custom nature of this invention, it is applicable to varying sizes of vessels.

The present invention also contemplates additional features for improving the integrity of the overall system during acts of war or attacks by criminals or terrorists who are attempting to cause oil spills by either dropping bombs, artillery shells, or the like on the upper surtaces of the ship, as well as impacting the sides and the underneath portions of the ship with torpedoes.

Some of The Savings Expected By Using Existing Retrofitted Vessels

By using the existing retrofitted vessels with this invention:

1) Literally billions of dollars will be saved that would have been used in constructing the new and vastly more expensive replacement vessels. The money saved can be invested at a much higher rate of return yielding greater profits than would have been lost in the purchase of new vessels before the existing ones actually require replacement due to extinction or mechanical failures.

2) The additional fuel necessary to move the heavier mass of double-hull tankers will be conserved while payload volume of transported crude will be maintained. When this savings is considered for every journey of every vessel during the lifetime of the vessel until mandatory replacement, this is a major environmental and financial savings making worldwide utilization of this invention even more feasible.

3) The ship scrap debris created from the unnecessary destruction (usually sinking to the ocean floor) of the entire world fleet of tankers will lessen the environmental impact on the world's refuse problem and the presence of sea-junk with its oxidation and ionic release into the sea.

4) And, the industry will have finally dealt with the actual petrochemical transport containment issues rather than just minimizing the risk but admitting the potential for failure of the other containment inventions. The potential damage to the environment as well as the financial outlay for clean-up or bio-remediation of spilled product is just too great to risk by not dealing with the actual problem at hand.

Positive Aspects of Utilizing This Invention

There are *many* positive reasons for utilization of this invention within the existing fleet of single-hull tankers that have been retrofitted with this present invention;

1) Improvement of existing vessels to deal with unexpected hull integrity problems;

2) Prevention of ecological tragedy that accompanies petrochemical spills;

3) Re-integration of vessel transport cell integrity following a hull breach where sea water enters the vessel;

4) Pre-Containment of Off-loaded crude;

5) Multiple-back-up system for off-loading of over-pressurized compartment contents;

6) Installation of invention with minimal time of vessel out of service;

7) Lower vessel hold maintenance costs;

8) Ability to change cargo type with more ease and safety from cross-contamination;

9) More safety to cleaning personnel of transport cells; and

10) Ability to protect off-loaded product from harm's way.

Summary of the Invention

An object of the present invention is to provide an improved cargo ship.

Another object of the present invention is to prevent hydrocarbon spills, or spills of other types of cargo, in the event the hull of a ship is breached.

An advantage of the present invention is a means for containing a hydrocarbon cargo, or other type of cargo, even after the hull or double hull of a ship is breached.

In the preferred embodiment of the invention, a method and apparatus are provided for containing cargo carried aboard a cargo carrier comprising a non-permeable, flexible bladder mounted within the carrier and in which the cargo is disposed and having an outlet port containing one or more check valves which allow the transported cargo to exit through such one or more check valves in the event the bladder is contacted by one or more objects which would otherwise cause the bladder to burst and spill the contents.

Therefore, in one embodiment the invention discloses an apparatus for containing cargo during a hull breach on a ship which comprises a non-permeable, flexible bladder mounted within the ship in which the cargo is disposed and a skeleton adjacent to the flexible bladder comprised of a plurality of relatively moveable elements for supporting the flexible bladder. The skeleton may be flexible and conformable to a shape of the flexible bladder. The plurality of relatively moveable elements forming the skeleton, in one embodiment, may comprise metallic links and/or metallic plates. There may be interconnecting metallic links mounted to the metallic plates.

This it should be appreciated that there has been described and illustrated herein new and improved methods and apparatus for preventing the spill of transported cargo aboard an oil tanker. However, the invention contemplates the use of such methods and apparatus for preventing the spills of various cargo materials on other means of transportation, for example, on barges, aircraft which are used as tankers for refueling other aircraft while in flight, tanker trucks which are used to transport oil or other fluid cargos over the highway system, and the like.

The invention may include means for permitting flow from the bladder to compensate for a sudden increase in pressure in the bladder caused by a hull breach. In one embodiment, a pressure sensitive valve is secured to the non-permeable flexible bladder. One or more pressure sensitive valves is operable to open to release the cargo in response to a sudden increase in pressure in the non-permeable bladder due to the hull breach. The valve may close once the pressure is reduced to a normal value to seal the remaining cargo within the flexible bladder.

In one presently preferred embodiment, a plurality of tanks are provided wherein each tank may be much smaller than the flexible bladder. The pressure sensitive valve may then release the cargo into the plurality of tanks to take care of the overflow due to the hull breach. Preferably, each of the plurality of tanks is expandable so that storage is compact. A header may be provided for receiving the cargo from the pressure sensitive valve responsive to the hull breach. As the header is filled, the expandable tanks are filled with the excess.

In operation, the present invention provides methods for containing cargo during a hull breach on a ship. The method may comprise such steps as releasing cargo from a flexible container through a valve in response to increased pressure in the flexible container produced by the hull breach and directing the released cargo into the header on the ship. The method may comprise other steps such as filling at least one expandable tank, preferably with the released

cargo in the header and may comprise releasing the at least one expandable tank overboard after being filled with the released cargo. The method preferably includes supporting the flexible container with a plurality of support elements flexibly interconnected together.

In other words, an apparatus is provided for containing cargo during a hull breach on a ship which preferably comprises elements such as a non-permeable bladder mounted within the ship in which the cargo is disposed, a flexible support structure in surrounding relationship to the non-permeable bladder, and a valve secured to the bladder. The valve is preferably operable to open for releasing the cargo through the valve responsive to a hull breach. The flexible support structure may take on many forms such as a plurality of elements moveably linked together. In a preferred embodiment, at least one expandable tank may be provided which is placed in communication with the valve for filling in response to the hull breach. In one embodiment of the invention, the valve is responsively opened by an increase in pressure caused by the hull breach. A header pipe is secured to the valve for receiving the cargo and directing the cargo, if necessary, to a plurality of expandable tanks which are secured to the header for receiving the cargo therefrom.

Brief Description of the Drawings

Figure 1 is cut away view of a ship hull containing the apparatus according to the present invention;

Figure 2 is a top view of a ship without the deck showing the deck hull hanging device and the meso-skeleton structure according to the present invention;

Figure 3 is a view of the meso-skeleton structure of the present invention installed in a ship and viewed from one end (stern view) of the ship;

Figure 4 is a perspective view of the meso-skeleton according to the present invention installed in the hull of a ship;

Figure 5 is a side view of a ship showing the bladder according to the present invention in the ship;

Figure 6 is a perspective view of the containment system in the hull of a ship with the bladder and meso-skeleton installed;

Figure 7 is an end view of a ship showing the bladder and meso skeleton installed in the ship with the transported product in the bladder;

Figure 8 is a side view of one embodiment of an offloading system according to the present invention;

Figure 9 is a top view of one embodiment according to the present invention of an **off-loading system** over a particular ship hold;

Figure 10 is another embodiment according to the present invention of an **off-loading system**;

Figure 11 is an end view of the ship with one embodiment according to the present invention of the **off-loading system** installed on the ship;

Figure 1A is a side view of the basic meso-skeleton unit according to the present invention;

Figure 1B contains two views of the knuckle device according to the present invention that joins the meso-skeleton together;

Figure 12A is a conventional double-hull tanker which can be fitted with an apparatus in accordance with the present invention;

Figure 12B is a top plan view of the tanker illustrated in Figure 12A;

Figures 13, 14 and 15 illustrate a plan view, transverse section, and an inboard view of the tanker illustrated in Figures 12A and 12B, respectively, with the apparatus in accordance with the present invention installed inside the cargo tanks illustrated in Figures 12A and 12B;

Figure 16 illustrates a stiffener used to form structure within the apparatus in accordance with the present invention;

Figure 17 (A)-(E) illustrates a meso-skeleton configuration of steel plates and steel chain links which provide a portion of the preferred embodiment of the present invention;

Figure 18 (a) and (b) further shows the ship illustrated in Figures 12A and 12B and including the apparatus in accordance with the present invention installed therein;

Figure 19 illustrates in a diagrammatic manner the effect of grounding a ship upon the bottom of the water through which the ship is traveling;

Figure 20 illustrates the effect of a side collision between the tanker illustrated in Figures 12 (A) and (B) and another sea-going vessel;

Figure 21 is a cross-sectional view of additional materials used in helping to resist the effect on the sides and bottom of a tanker resulting from terrorists' attacks or other acts of war;

Figure 22 illustrates schematically pillows which can be used to replace the loose powdered materials illustrated in Figure 21; and

Figure 23 illustrates, partly in cross-section, an elevated view of laminated materials which are used to strengthen the upper deck of the ship in accordance with the present invention.

Detailed Description of the Invention

The following definitions are used in describing this invention:

Meso-skeleton is the protective, intentionally deformable infrastructure that has been developed

to lay passively against the ships hull in the hold. The meso-skeleton occupies minimal space in the hold yet provides an important force distribution protective function at the moment of hull breach.

Meso-skeleton elements (add as Figure 1A the Triangle with the knuckle joints) have **tubular members 200** with meso-skeleton element joints, **articulating condyle member 201**, and also **knuckle joints 202**. Further the tubular members have **sleeves 204** over the tubular members.

Meso-skeleton element joints 202 are shaped as a knuckle that will allow the three contacting ball elements of adjoining meso-skeleton elements to have wide range of motions in multiple axes.

Skeleton strips (not shown) are created using a connecting sleeve (not shown) that in a preferred embodiment can be latched over tubular members 200 to connect two tubular members together creating the meso-skeleton 100 using **Sleeve Connectors 205**, otherwise, the knuckle/meso-skeleton element joints join the basic elements together.

Figure 2 shows the **Deck hull hanging device 103** having a **rod 105**, at least one **plate 104**, but preferably a plurality of plates. There are **intermediate rivets 106** that attach the plate to the deck's hull and support structure.

The ships **bulkheads 101** serve as interrupters of cells into functioning units.

Figure 3 shows the **deck hull hanging device 103** with at least two **support struts 132 and 134**.

Figure 4 shows the **entry port 102** for the bladder attached to the deck hull.

Figures 5 and 6 show **bladder 136** contained in the hold of a ship.

Bladder neck 138 is positioned to extend up into the **port 102**.

Figure 7 shows the **bladder support means 140**. The **pressure sensitive valve 142** is shown as well.

Figure 1A shows the equilateral triangles used to create the meso-skeleton. They contain tubular members 200, a tubular sleeve 204 and sliding connecting means 200, 201 and 202.

The Offloading Device is shown in Figures 8 through 11. Particularly in Figure 8, are shown **the compressed capsules 144** for receiving product. A five-way offloading device is depicted in Figures 9 and a parallel offloading device is depicted in Figure 8 and Figure 10. The **offloading troughs 110** which transport the loaded capsules 144 for storage or further deployment are shown in Figure 8 and 10.

The present invention relates to a method and apparatus for Hull breach containment system.

The following is the detailed description of the invention.

Meso-skeleton elements:

Referring now to Figure 1A in more detail, ***Meso-skeleton elements*** are apparatus according to one embodiment of the invention, that are equilateral triangles, preferably constructed from **three tubular members 200** with an **articulating condyle 201** on each end of **tubular members 200.** In this embodiment each tubular member would have an outer diameter ranging from 0.5 to 1.5 inch and preferably 0.75 inches outer diameter. In the most preferred embodiment, the tubular members could be solid. Each tubular member would have a **joint or knuckle 202** (observed in Figure 1B) capable of attaching to at least one or more tubular member providing movement in three planes; on three axes with up to 180 degree movement possible is the key element of the preferred embodiment.

The equilateral triangles are preferably stainless steel, and preferably solid, however,

strong or reinforced hollow members can be used within the scope of this invention. The triangles could be made of legs that are tubular, rectangular, or octagonal in shape. Other shapes may be usable within the scope of the present invention, provided they can be jointed together with the unique tubular joints.

The preferable size of the meso-skeleton element is 1 foot length per leg in the preferred embodiment, but size could vary from being as short as 6 inches to as long as 18 inches. Longer or shorter legs may be used. However, such longer length legs would need to be constructed from graphite composite or ultra strong materials so that the meso-skeleton element (Figure 1B) does not deform upon itself when pressure is applied to it as a functioning unit.

The tubular members of the meso-skeleton may additionally be covered in a **tubular sleeve 204**, preferably from a rolled sheet metal, preferably the same material as the tubular members, however, a coated sleeve, such as powder coated steel, or silicon, or elastomeric or polymeric lined material which would prevent corrosion of the tubular members and permit additional rolling of the tubular members against the unique bladder combination without tearing the tubular member and relieving the possibility of any adhesion of the tubular member against the bladder.

Optionally, the meso-skeleton elements could be construed of solid triangular materials or otherwise that have strong supporting sides. The solid element could be a fabric, which would cover the side structural elements and provide further cushioning against the bladder. The cover for the bladder could for example, be fabricated from leather, cloth, plastic or other flexible materials. As a specific example, the cover could be fabricated from the KEVLAR product manufactured by or on behalf of I.E. duPont de Nemours and Company of Wilmington, Delaware. KEVLAR is the trademark of Dupont. The KEVLAR material is a flexible, synthetic

fiber of high tensile strength which has been used to make bullet proof vests among other things. Suffice it to say at this point that the function served by the cover which is formed by the meso-skeleton elements of this present invention could also be performed by various other materials to allow intruding objects such as another boat hull to push against the cover and hence against the bladder to perform the various objects of this present invention.

Meso-skeleton element joints:

The legs of the triangles are connected together with **rotatable joints 202**, similar to a knuckle type joint, permitting multi-axis rotation of three connections as well as translation of force from each leg through the joint.

Skeleton Strips:

Meso-skeleton elements are prejoined into skeleton strips. In the preferred embodiment, the strips are created to either be one, two, three or more meso-skeleton elements wide (as in Figure 4) strips which can be anywhere from 5 elements up to 150 elements or more in length. The strips are attached at one end to a ***deck hull hanging device*** (Figure 1, 2, 3, 4, 5, 7, 8, 9, 10, and 11) and then the strips are connected together by tack welding **134**, and fitted against the side of the interior of the hull.

The meso-skeleton strips can be connected together by placing a ***connecting sleeve 205*** **Figure 1B** around the sleeved tubular member of adjoining skeleton strips thereby containing two sleeved tubular members on one connecting sleeve. The connecting sleeve could be a hinged device capable of clamping over the sleeves for easy installation in the field.

Deck Hull Hanging Device

The deck hull-hanging device comprises a series of **flat rectangular plates 104** that extend from the bow of the ship to the stern, and each plate specifically extends from the edge

of one bulkhead in the hold of the ship to the edge of the next bulkhead in the hold of the ship. The plates are placed as close as possible to the edge of the ship's hull-deck interface. The plates extend from bow to stern on each side of the ship, both the starboard side and the port side. It is even contemplated that this device could be used to extend across the stern of the ship as well and provide protection on all exposed sides of the vessel. It is possible that the plates could be stopped prior to meeting at the bow, as the bow compartment typically does not hold cargo such as oil or similar materials.

The plates are bolted, riveted or welded to the superstructure of the deck, so that the deck hull-hanging device maximizes the support of the plates while connected to the meso-skeleton. A main **hanging support rod 105** is placed under the deck in the hold and in line with the plates that are on the deck. The rod is connected to each plate via a volt which extends from the rod through the deck, through the plate and is bolted, welded or riveted to the plates. If the plates do not extend the full length of the ship, it is contemplated that two rods would be used within the scope of the present invention within each cargo compartment of the hold. The deck plates that support the hanging support rod are intended to provide weight transfer or load transfer in the vertical plane.

A **support strut 134** (Figure 2, 3, 4, and 11) for connecting the rod to the interior hull of the ship is used in the preferred embodiment so as to provide weight transfer or load transfer laterally which impact the rod due to stresses on the meso-skeleton. Depending on the weight of the meso-skeleton, it may be possible to not use the support strut and only use the deck plates to support the rod holding the meso-skeleton. At least two support struts per rod are contemplated, but additional support struts can be used depending on the size of the hold of the ship. Preferably, each time the rod is connected to the deck, a support strut should be used against the interior hull

of the vessel.

The support strut can be welded to the hull, rivets or otherwise connected to the interior hull of the ship.

Sliding connecting means 205 Figure 1B, such as a stainless steel loop or a coated metal loop, or similar slidable mechanism can be used to hold the meso-skeleton onto the rod. The sliding connecting means attaches to the meso-skeleton by fitting over the tubular sleeve of the meso-skeleton element that is parallel to the rod.

Bladder 136:

A bladder (Fig. 5) having a neck and at least one bladder support means is used with this invention. The bladder is preferably made of a strong material, such as rubber, KEVLAR, PEEK, PFTE or a similar super strong flexible, fabric-like material. Teflon-coated nylons or other coated polymeric materials may be usable within the scope of the present invention if they are strong, resistant to both salt water and hydrocarbon degradation and other chemical corrosion. Woven and non-woven materials may be usable within the scope of the present invention.

The bladder is preferably custom designed in size to exactly match the size dimensions of the ship hold into which it is to reside. The bladder is designed so that it is contained laterally and interiorly by the meso-skeleton structure. The bladder is lowered through a deck port into the hold and then partially inflated so that the bladder lies against the meso-skeleton which has already been inserted in the hull of the ship. Cargo, such as oil, water, fertilizer, grain, or other fluids, including wine or beer, could be then flowed into the bladder through a conventional fill and discharge port, preferably, located on the top surface of the bladder. Remaining air is then evacuated form within the bladder to provide a bladder containing only cargo. The bladder is then sealed such as with a **pressure sensitive valve 142** that is capable of monitoring and maintaining

will no longer be in direct contact with the oil, but instead will be exposed to a damp, salty, and corrosive atmosphere. Preservative coatings will need to be applied in the tank spaces. These coatings will need to be frequently renewed as a result of metal-to-metal contact between the meso-skeleton and the tank structure that will probably harm the coatings.

- Deck Access - Large hatches will need to be provided in the main deck, above each cargo tank, to facilitate the initial installation of the meso-skeleton and the installation and removal of the containment system bladders.
- Inert Gas System - The existing inert gas system for tanks would have to be modified to provide for inert gas both inside and outside of the bladders. Although the bladder system will normally isolate the cargo from the internal tank structure, and thereby reduce the chance of an explosion during an accident, it is likely that over time, small quantities of fuel or vapor, originating from the area of the bladder/overflow pipe attachment, will accumulate in the atmosphere outside of the bag but inside the tank. Such vapors could be ignited form a spark generated from the metal-to-metal contact of the meso-skeleton against the tank structure.
- Tank Cleaning System - It may be possible to remove the tank cleaning system if it is feasible to change the bladders easily and inexpensively.
- Inspection Safety - The ability to remove the bladders while in port would reduce the danger currently experienced for inspection personnel exposed to dangerous solvents within an enclosed area. However, the length of time needed to conduct inspections will increase because the presence of the meso-skeleton will make

inspection of the tank structure more difficult to accomplish (impossible without moving meso-skeleton aside).

- Reduced Full Load Ship Displacement - Although the bladder and meso-skeleton add weight to the ship, this addition is more than offset by the reduction in weight resulting from the reduced quantity of oil being carried. The resulting full load ship displacement will be about 4400 LT less than a similar tanker that is not outfitted with the system. This quantity will also vary for tankers of differing sizes or configurations. This reduced full load ship displacement may result in a slight increase in fuel economy for the tanker.
- A conventional cargo heating system should be provided for the bladder to facilitate removal of oil.

The system which has been described herein above has for the most part been a system for handling high mass, low velocity, large momentum hull breaches which would endanger the ability of a tanker to handle a hull breach. It has become increasingly more important and necessary to augment the above described system to include protection from low mass, high velocity projectiles which could approach a vessel not only from under the sea in the unlikely form of a torpedo but also more likely above the water line in the form of a missile, a bomb or another explosive projectile.

Because it will be necessary to strip the deck of the ship during the retrofitting of the systems described herein to install the deck portals, which will house bladder nipple extensions, at the time of reinstalling the deck a new projectile resistant deck will be installed as described herein below. The deck in accordance with the invention, is a lightweight, laminated structure as described with respect to Figures 21, 22 and 23. Referring first to Figure 23, the outer surface

of the upper deck comprises a metallic layer 800, for example, fabricated from carbon steel, and is preferably several inches thick. Immediately underneath the metallic layer 800 is a thick, belted fabric, material 802, for example, being .5" to 1.0" thick, fabricated from Kevlar, with the layer 802 attached to the outer unit rim. A layer 804 comprises approximately 5 to 7 inches of sodium bicarbonate powder or some other suitable oxygen scavenger which may simply be comprised of powdered sodium bicarbonate or may be in the form of pillows containing sodium bicarbonate powder described hereinafter with respect to Figure 22. The next layer is layer 806 which is also a thick (.5" to 1.0"), belted fabric interface fabricated, for example, from Kevlar. Immediately beneath the fabric layer 806 is another metallic layer, for example fabricated from carbon steel. Passing through the laminated structure of Figure 23 is the pipe section 812 which is used to fill and discharge oil or other liquids from within the bladder 810.

Referring now to Figure 21, there is illustrated in cross-sectional view a portion of the bladder 810 which has on its exterior a first fabric layer 808, for example, Kevlar, a layer of powdered sodium bicarbonate 804, the meso-skeleton layer 805, and the second fabric layer 802, for example, Kevlar. As illustrated in Figure 21, the two fabric layers 802 and 808 have between them a layer of the sodium bicarbonate 804. Without some form of intervention, the powdered sodium bicarbonate would drift downwardly causing the layers 802 and 808 to come closer together and perhaps even touch. Accordingly, the layers 802 and 808 are separated by a plurality of plastic spacers 820 which, if desired, can be spaced along the entire length of the laminate structure illustrated in Figure 21. It should be appreciated that the structure of Figure 21 completely surrounds the bladder 810, other than for its top surface.

As illustrated in Figure 22, an alternative mode for being used as the oxygen scavenger 804 illustrated in Figure 21 is the plurality of sodium bicarbonate pillows 822 which contain

sodium bicarbonate powder or another oxygen scavenger, foam, for example, which can be stacked between the layers 802 and 808 of Figure 21 in place of the loose, powdered sodium bicarbonate illustrated in Figure 21. This eliminates the need for using the spacers 820.

In summary, by having the structure illustrated in Figure 23 above the top surface of the bladder 810 and by having the structure illustrated in Figures 21 or 22 around the lateral portions of the bladder and beneath the bladder, the bladder 810 is thus surrounded by the laminated structures of Figure 21-23 and serves as a resistance against terrorism on the top surface of the deck, and the structure illustrated in Figures 21 and 22, completely surrounding the bladder beneath the upper structure of the ship's deck, there is an increased resistance to attacks, either in war or as against acts of terrorism involving the use of bombs, missiles, torpedoes, or the like. In this process, a projectile will first encounter the ballistic cloth if it comes in from the side or underneath the bladder and will then engage the sodium bicarbonate. The projectile will then encounter the meso-skeleton itself and then again the fire retardant powder and finally the inner layer of ballistic cloth before gaining access to the containment bladder. Should a fire be involved, the fire retardant, typically an oxygen scavenging powder or foam, will minimize the support of combustion which would otherwise ignite the cargo being transported.